

A Conservative Phenomenological Model of Large-Scale Bulk Flow from Anisotropic Effective Sourcing

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Abstract

This document consolidates the full Zenodo-ready release of the Anisotropic Effective-Source Model for Large-Scale Bulk Flow. It includes the manuscript, derivation, test procedures, reproducibility notes, metadata, and reference code in a single archival PDF.

Manuscript: Core Model

The model describes coherent bulk flow as arising from an anisotropic effective gravitational potential within the weak-field (Newtonian) limit. Locality, causality, and conservation are preserved by treating anisotropy as a boundary or initial condition.

Key Equations

$$\nabla^2\Phi_{\text{eff}} = 4\pi G(\rho_{\text{m}} + \rho_{\text{ext}}) - \lambda_{\text{s}} \nabla \cdot (\sigma \nabla \Phi_{\text{eff}})$$

$$\rho_{\text{ext}} = \zeta \cdot b \cdot \rho_{\text{p}}$$

$$\mathbf{v}_{\text{df}} = - \mu \nabla \Phi_{\text{eff}}$$

Falsifiable Test Procedures

Bulk flow vectors are estimated using peculiar-velocity or kSZ data and compared against isotropic mock catalogs. Statistical significance is assessed via amplitude, direction stability, and hemisphere asymmetry tests.

README Summary

This model is phenomenological and does not assert a microscopic mechanism or superluminal interaction. It provides a mathematically consistent framework suitable for empirical testing and falsification.

Zenodo Metadata

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Appendix: Reference Code

```
def fit_bulk_flow(rhat, vlos, sigma):  
    w = 1.0 / sigma**2  
    A = rhat  
    ATA = A.T @ (w[:,None] * A)  
    ATv = A.T @ (w * vlos)  
    V = np.linalg.solve(ATA, ATv)  
    cov = np.linalg.inv(ATA)  
    return V, cov
```